Notes.

NEXT week's issue of NATURE, February 17, will be a special number devoted to articles upon the principle of relativity. We have been fortunate in securing contributions from leading authorities upon this subject, including Prof. Einstein himself, and the whole number will form the most important presentation of its various scientific aspects yet published. The principle is of such wide significance, and so many books and papers have been written upon it, that a synoptic statement of its structure and consequences will be of permanent value.

THE Actonian prize of the Royal Institution has been awarded to Prof. G. E. Hale, director of the Mount Wilson Solar Observatory, California, for his contributions to solar physics. On Saturday next, February 12, at 3 o'clock, Prof. A. Fowler will begin a course of three lectures at the institution on spectroscopy. The Friday evening discourse on February 11 will be delivered by Dr. F. W. Aston on isotopes and atomic weights, and on February 18 by Mr. Solomon J. Solomon on strategic camouflage.

THE newly incorporated Institute of Physics has issued a pamphlet describing its objects and giving the regulations for the admission of members. The institute proposes to grant diplomas to members indicating a high standard of professional competency, and hopes in this way to secure proper recognition of the professional status of the physicist. It will serve also to co-ordinate the work of existing societies connected with physics and its applications. Any member of a "participating society" is eligible as an ordinary member of the institute, but to become an associate or a fellow he must satisfy certain other conditions which relate generally to his training as a physicist and to the importance of the work in physics in which he has been engaged. The annual subscriptions are: for fellows and associates, two guineas and one guinea respectively, while ordinary members pay no subscription. A member of two or more participating societies pays a reduced subscription to those societies, and under certain conditions the charges for the publications of the societies are reduced. The office of the institute is at 10 Essex Street, W.C.2.

SIR JAMES J. DOBBIE, whose recent retirement from the position of Government Chemist and Principal of the Government Laboratory, held by him since 1909, was referred to last week, has to his credit a considerable amount of research work, particularly relating to the constitution of the alkaloids. He has also devoted much attention, in conjunction with the late Prof. Hartley, to the study of absorption spectra, with special reference to the relation between absorption and chemical constitution, and a large number of papers on these subjects were published in the Transactions of the Chemical Society between 1898 and 1912. Quite recently he contributed papers to the Royal Society (conjointly with Dr. Fox, of the Government Laboratory) on the absorption of light by elements in a state of vapour in relation to their molecular constitution. As Government Chemist Sir James Dobbie has been responsible for numerous important investigations for various Government Departments, such as the nature of the pigments used for postage and other stamps, the properties of celluloid, the preservation of the timber in the roof of Westminster Hall, etc. During the war a large amount of difficult and responsible work was thrown upon the Government Laboratory in connection with the War Trade Department, the analysis of metals and alloys for the Air Board and Admiralty, and the examination of food-supplies for the Expeditionary Forces. Chemical stations were established at the principal supply depôts, and it is acknowledged that the almost total absence of complaints from the Front as to the quality of the food was largely due to the work of the Government Laboratory. Sir James Dobbie is a past-president of the Institute of Chemistry, and is just about to complete his term of office as president of the Chemical Society. We trust that his right to complete enjoyment of his well-earned *otium cum dignitate* may not be long delayed.

A NUMBER of conferences on questions of national interest are announced for the *Daily Mail* Efficiency Exhibition to be held at Olympia on February 10–26. The meetings of the first four days will be devoted to personal efficiency and public health; on February 10 Dr. C. W. Saleeby will speak on child welfare and maternity, and Mr. E. B. Turner, Dr. Latham, and Mr. E. Farmer on industrial fatigue. Sir H. Baldwin, Prof. E. L. Collis, and Mr. F. Watts will discuss preventable diseases on February 11. Both conferences arranged for February 14 will deal with fatigue elimination; the speakers will be Major F. Gilbreth, Mr. Eric Farmer, Dr. H. M. Vernon, and Prof. A. F. Stanley Kent. Fuel efficiency will be discussed on February 17 and 18, when Mr. F. W. Goodenough will deal with coal gas and Capt. R. H. Montgomery with motor fuel. A number of evening medical conferences have also been arranged by the Middlesex Hospital. On February 14, 16, and 23 Dr. W. B. Tuck will speak on the relations between chemical research and medicine, health and pharmacology; and Dr. W. S. Lazarus-Barlow will discuss fluorescence, X-rays, and radium on February 15, 18, and 25. All conferences will be open to visitors to the exhibition, but societies and individuals desirous of taking part in them should apply for special tickets to the Higher Production Council, 66 Victoria Street, London, S.W.1.

MR. L. BOLTON, a senior examiner in the Patent Office, London, has been awarded the prize, amounting to about 1300*l.*, offered by the *Scientific American* for the clearest explanation for general readers of Prof. Einstein's theory of relativity.

AT the annual meeting of the Yorkshire Numismatic Society, held at Leeds University on February 5, the society's first annual medal was presented to Mr. T. Sheppard, curator of the Hull Museums, in recognition of his contributions to the study of numismatics.

A DESTRUCTIVE earthquake occurred on February 4 on the Isthmus of Tehuantepec separating the Gulf of Mexico from the Pacific. According to messages received in the United States from Mexico City, considerable loss of life was caused and much damage to property.

A JOINT meeting of the Faraday Society and the Manchester Literary and Philosophical Society will be held at 36 George Street, Manchester, to-morrow, February 11, at 6.30 p.m. The meeting will be presided over by Sir Henry Miers, president of the Manchester Literary and Philosophical Society, and Prof. A. W. Porter, president of the Faraday Society. The subject to be discussed will be "Measurements of Surface Tension," and it will be opened by Dr. Allan Ferguson.

DR. W. CROOKE discusses certain curious rites at the accession of Rajas in India in the January issue of *Man*. In Vedic times the Raja used to start in his chariot and shoot an arrow at an animal from the herd of one of his relations. Even so recently as 1886, when Madhava Rao Sindhia was invested, the farm was given over to plunder, the sufferers being afterwards compensated at the cost of the State. When a Rajput Raja came to the throne his first duty was to perform the "inaugural foray" by marching against and sacking a town belonging to a neighbouring chief. These are what French anthropologists call *rites de passage,* ceremonies at periods of crisis performed with a magical intent. They represent the period of anarchy occurring between the death of a Raja and the accession of his successor. The new Raja performs an act of bravery or redresses an admitted grievance, such acts being of happy augury for the future reign.

DRS. R. W. HEGNER and G. C. Payne in the *Scientific Monthly* for January (vol. xii., No. 1, p. 47) give a summary of the intestinal protozoa of man in health and disease. They express the hope that the discussion of the subjects presented in this paper will stimulate investigation, and they plead for a carefully organised survey of the intestinal protozoa among civil communities.

WE have received the report of the Research Defence Society for the last quarter of 1920. The society has now been in existence since January, 1908, and its propaganda work has been very valuable in the cause of biological science. The president and treasurers of the International Medical Congress of 1913 have handed over to the society the surplus of the funds of the congress, amounting to some 35*l*. Mr. Stephen Paget is no longer hon. secretary, having been elected vice-chairman of committee, but he will continue writing and advising for the society. Miss Dorothy Burgiss-Brown remains as secretary.

IN connection with the attempt to scale Mount Everest, which is to be made by the Royal Geographical Society and Alpine Club's expedition, it is of interest to learn the views of Col. H. H. Godwin-Austen, whose surveying experiences in Kashmir date back to 1857 and in Bhutan to 1863. Col. Godwin-Austen, in an article in the *Surrey Advertiser* for January 22, expresses the opinion that the best men for the task will be found in the Survey Department of India, and he believes that the number of climbers even in the reconnaissance party projected for the coming summer should be small. He recalls some of his experiences in the first surveys made in Sikkim and the views of Mount Everest which he had from Senchal, near Darjeeling, in 1863. Incidentally, he thinks that the discovery of a route to Mount Everest may not prove a very difficult task.

WE have received from Messrs. W. and A. K. Johnston several sheets of the survey on a scale of 1 : 125,000 of the Gold Coast, prepared under the direction of Major F. G. Guggisberg and engraved and printed in Edinburgh. Each sheet is ½° square, with full reference in the margin to conventional signs and orthography. Hill features are shown by brown shading, but there are no contours; water features and names are in blue, and boundaries in red and brown. The maps are clear and finely engraved, and contain a great deal of information without any crowding or illegibility. The sheets published cover the whole of the Gold Coast, and join in the north the War Office 1 : 250,000 sheets of Ashanti.

Two useful articles on Spitsbergen appear in *Naturen* for September–October, 1920, the publication of the Bergen Museum. Prof. B. J. Birkeland, in writing on the climate, has been at pains to collect most of the meteorological data, some of them previously unpublished, which have been taken at various times. In addition to means of seven years from the Norwegian wireless telegraph station at Green Harbour and Swedish records from Cape Thordsen and Mossel and Treurenberg Bays, Prof. Birkeland gives five years' records from Axel Island, in Bell Sound, three years' from South Cape, and several years' from different stations in Edge and Barents Islands. The South Cape, Edge Island, and Barents Island records, having been made by winter hunters, are in most cases incomplete for the summer months. No data are given from the former Russian station in Horn Sound or from the German station in Cross Bay. The second paper, by Mr. O. Holtedahl, deals with the geology of Spitsbergen and Bear Island, and includes two revised geological sketch-maps, besides several illustrations.

IN 1902 Miss Rathbun, of Washington, described three specimens of a tiny prawn found in the Galapagos and belonging to the crustacean group Caridea. On them she established a new genus Discias, the representative of a new family combining highly specialised characters with others that appear to be primitive. In the Records of the Indian Museum (vol. xix., part 4) Dr. S. Kemp describes a new, but closely related, species from five specimens (male and female) found on a sponge in the Andaman Islands, which are "separated from the Galapagos Islands by almost exactly half the circumference of the globe." A full-page shaded drawing of an "ovigerous female" is reproduced by photogravure—a luxury indicating the importance attached to the discovery; but if Dr.

Kemp was the artist he should have included a scale. Among the many figures in this part of the Records the magnification is given in only four cases.

IN the Proceedings of the United States National Museum (vol. lviii., No. 2344) Messrs. C. P. Alexander and W. L. McAtie deal with the crane-flies and their allies (Tipuloidea) found in the District of Columbia. These insects are prevalent in almost all parts of the world, and they are restricted only by intense cold and dryness. Water or moisture is a necessary condition for the development of most species, and, consequently, deserts form efficient barriers to their dispersal. Among the more interesting features in this paper is a note on the occurrence of the rare and primitive insect *Protoplasa Fitchii*; several larvæ which are referred to this species were found in a decayed drift log, but the adults were not bred out. The winter-gnats (Trichocera) are represented by three species, and the authors follow other recent writers in referring this genus to the Rhyphidæ. The greater part of the paper is devoted to the rich fauna belonging to the family Tipulidæ, which is represented by 40 genera and more than 190 species. The authors include notes on the larval habits of all species wherever known, and they append useful synoptic keys to the various groups along with their genera and species.

PROFS. A. C. SEWARD and B. Sahni have contributed to the Palæontologia Indica (vol. vii., Mem. 1, in Memoirs of the Geological Survey of India, 1920) a memoir entitled "Indian Gondwana Plants: A Revision." The specimens were mostly among those described by Feistmantel, but a revision of the species in the light of modern knowledge had become necessary. The memoir is illustrated by seven fine folio plates, partly photographic, partly from drawings by Mr. T. A. Brock, as well as by a few figures in the text. The senior author was helped in the early stages of his work by Miss Ruth Holden, a young American botanist, whose premature death while on medical service in Russia is a grave loss to science. Prof. Sahni came in at a later period, and hopes to continue work on the same lines in his own country. Two quite distinct floras are dealt with: the Lower Gondwana, of Permo-Carboniferous age, and the Upper Gondwana, which is Jurassic. As regards the former, the authors point out that their results suggest a closer resemblance between the Indian plants and their contemporaries in Europe and North America than had hitherto been realised. For example, the Gondwana genus Nœggerathiopsis is now merged in the familiar Cordaites. The specimens from the Upper Gondwana include several good examples of Williamsonia fructifications, very similar to the well-known European fossils, and to those from Mexico recently described by Dr. Wieland. This illustrates the author's conclusion that the examination of the Indian Jurassic species has revealed additional evidence of the remarkable uniformity of Jurassic floras of widely separated regions. The specimens described in the memoir are impressions, not petrifactions showing the structure, but use has frequently been made of modern methods to bring out such microscopic details, *i.e.* of the epidermis, as can be recognised.

THE Archives of the Cambridge University Forestry Association (No. 4, October, 1920) contains an illustrated article by Mr. H. Stone on the origin of the so-called medullary rays in wood. This paper, which advocates a new theory, contains some information about bird's-eye maple and the cause and nature of the pith-flecks which are so characteristic of birch and certain other woods. The author also discusses the capricious occurrence in the natural orders and in allied genera of the broad compound rays which give rise to "figure" in oak, beech, and plane.

THE Queensland Geological Survey Publication No. 267 (1920) is a description of petrified plant remains from the Queensland Mesozoic and Tertiary formations, by Prof. Birbal Sahni. The series includes two ferns belonging to the genus Osmundites which were previously known only from Jurassic rocks in New Zealand; seven species of gymnospermous woods, six of which are described as new; and three species of angiospermous woods, two of which are new.

THE Norwegian Meteorological Institute has published its Jahrbuch for 1919, containing records of the observations of more than seventy stations. Hourly records are given for Kristiania and Aas, daily means for twelve stations between Mandal in the south and Vardö in the north, and monthly means for the other stations. An appendix gives the observations at Green Harbour, Spitsbergen, for the year 1918–19. The institute has also published "Nedböriagttagelser i Norge," giving the precipitation records for 1919 for 491 stations and a large-scale coloured map showing the distribution of the year's precipitation.

DR. MURRAY STUART's final report on the Srimangal earthquake of July 8, 1918, is published in the last part of the Memoirs of the Geological Survey of India (vol. xlvi., 1920, pp. 1–70), the principal results having been already given in a preliminary report (see NATURE for April 3, 1919, p. 91). The new memoir contains full details of the nature of the shock and the damage to property, a discussion of the seismograms at distant observatories, and an account of the changes of level in the central district. The epicentre is situated in the Balisera Valley, 3½ miles south of Srimangal railway station, and the epicentral area (the longer axis of which is directed about west-north-west) is crossed centrally at right angles by the line of levels made in 1911–12 from Silchar to Comilla. During the winter of 1919–20 the levelling along this line was repeated by the trigonometrical survey, and this shows that in the interval no settlement had taken place on the north-east side of the epicentral axis. Nor is there any evidence of disturbance on the other side of the axis until the low range of hills six miles west of Srimangal is crossed, but from this range to a distance of thirty miles from the town a subsidence of from 1½ in. to 9 in. has occurred. It would thus seem that "the earthquake was due to subsidence along the southern side of a normal fault cutting the rocks below the alluvium of the Sylhet district, and situated approximately under the major axis of the epicentral area."

La Nature for January 22 contains an illustrated article by M. Léon Laffitte on the methods which are being used by the French naval authorities to refloat those vessels which were torpedoed during the war and sank in situations which render them dangerous to navigation. Maps are given on which the position and name of each submerged wreck are marked. No numbers are mentioned by the author, but the maps show that at least 200 vessels, many of them near the entrances to the larger ports, were lost. The operations are directed by three captains of the fleet, and in most cases are carried out by the compressed-air method, temporary wooden patches being fixed by divers over the holes made in the sides of the vessel by the torpedoes. It is found possible to carry out this work down to a depth of 180 ft.

IN a paper read recently before the Institution of Petroleum Technologists Mr. F. H. Garner, of the Mellon Institute, Pittsburgh, discussed the importance of the carbonisation constant of lubricating oils. This constant is determined by exposing the oil to a definite temperature in an oxidising atmosphere, and then measuring the quantity of asphaltene produced. The carbonisation constant is closely connected with the content of resinous matter in the oil, which may be extracted by utilising the selective adsorption of charcoal for these resins. The Conradson coke test was brought forward as an important means of discriminating between different lubricating oils, and it was shown that this criterion was particularly valuable in connection with internal-combustion engines.

DR. H. E. ARMSTRONG has a charming address on "Detective Work in the Potbank" in the current issue of the Transactions of the Ceramic Society. He shows that, if rightly interpreted, the story of the "crime" committed when, say, iron rusts, so that a valuable strong metal is changed to a worthless powder, is as exciting in its way as the shilling-shocker detective story. He utilises the discovery of the composition of limestone to give his views on the general principles which obtain in the application of science to the manufacture of pottery in particular and to the industries in general. The title of Dr. Armstrong's address is singularly appropriate, because much of the so-called application of science to the industries is an application of the detective instinct in locating sources of loss.

IT appears from the *Procès-Verbaux* of the last meeting of the International Committee of Weights and Measures that it will be proposed at the general conference in September next that the functions of the International Bureau shall no longer be confined to the construction and verification of standards of length and mass, but extended to include other units and standards, as well as the determination of physical constants. In the event of this being agreed to by the countries participating in the metric convention, a commencement will probably be made with electrical units and standards. The conference will also consider a proposition to increase the fixed annual budget of the Bureau from the present figure of 100,000 francs to 250,000 or 300,000 francs. The periodical recomparisons of the iridio-platinum national prototypes of the metre and the kilogram are now in progress at the Bureau, and preliminary observations on four of the metres seem to indicate that all of them have undergone a small diminution of length, of the order of half a micron, since their original verification more than thirty years ago. The investigation of the properties of nickel-steel alloys, which led to the discovery of invar, has been resumed, and it has been found that by the addition of 12 per cent. of chromium to alloys of the invar type a metal ("elinvar") is obtained which exhibits a constant modulus of elasticity throughout a wide range of temperature.

A REPORT has now been issued by the Department of Scientific and Industrial Research giving particulars of the work accomplished by the lubricants and lubrication committee. The report fills 126 pages, and contains a large amount of interesting information. A bibliography has been compiled, to be published separately, containing classified references to every published work or paper on lubricants or lubrication of definite importance; abstracts of a large number of important papers are also given in the bibliography, and a complete translation of Prof. Otto Faust's researches on the increase in the viscosity of certain liquids with pressure appears in the report. Research work has also been carried out on behalf of the committee; complete reports and the results of each individual research are given in appendices to the report. There are also a summary of the existing knowledge of lubrication and recommendations for future research on lubricants and lubrication. The tests on the viscosity of liquids at high pressure are of particular interest; in Mr. Hyde's experiments, carried out at the National Physical Laboratory, it was found that all the oils tested showed a rapid increase in viscosity with pressure, and the increase was much greater for the mineral than for the animal and vegetable oils. Castor (vegetable) and Trotter (animal) gave almost identical results up to about 4 tons per sq. in., but at 8 tons per sq. in. the Castor had increased to 5·5 times and the Trotter to 5 times their atmospheric values. The report can be obtained from His Majesty's Stationery Office, price 2*s*. 6*d*. net, and those interested in this subject are recommended to procure a copy.

WE have received from the British Scientific Apparatus Manufacturers, Ltd., 198 rue Saint-Jacques, Paris (5e), a general catalogue (in French) of the instruments and apparatus manufactured by its members. This company was formed in February last with the object of making British scientific products more widely known in foreign countries; it serves generally as an advertising medium and a connecting link between manufacturers at home and consumers abroad. The first action of the company was to establish a showroom in Paris, which is now well stocked with samples. Not only can visitors to the showroom obtain full information regarding the apparatus, but also in most cases facilities are available for the demonstration of the exhibits. Although the showroom has been open for a few months only, the results are most encouraging, and a considerable number of inquiries are being dealt with daily. Paris is found to be essentially suitable for a centre of this sort, as is shown by the fact that the visitors' book already contains names of visitors from thirteen different countries. The general catalogue is divided into nine sections under the following headings;—(1) Chimie, Industries chimiques. (2) Electricité, Industrie électrique. (3) Marine. (4) Aviation, Aérodynamique. (5) Métallurgie, Mécanique de précision, etc. (6) Médecine, Bactériologie, Physiologie, Ophtalmologie, etc. (7) Topographie, Géodésie, Astronomie, Météorologie, Dessin. (8) Physique expérimentale. (9) Photographie, Cinématographie. It will be seen that the range of apparatus covered is very extensive. In connection with their Paris showroom the "B.S.A.M." have formed a reference library of English scientific and technical books which are at the disposal of visitors. The showroom is under the management of Mr. F. C. Dannatt.

DR. NORMAN R. CAMPBELL is bringing out, through Messrs. Methuen and Co., Ltd., a work entitled "What is Science?" the aim of which is to explain what science really is and the kind of satisfaction which may be derived from its study. Two other books in Messrs. Methuen's spring list make an especial appeal to readers of NATURE, viz. "Atomic Theories," by F. H. Loring, and "Biological Chemistry: The Application of Chemistry to Biological Problems," by Prof. H. E. Roaf. The first-named volume is written to give in a concise and simple form an account of all the important theoretical and experimental researches on the atom, its structure, and the arrangement of electrons in atoms, in molecules, and in ions. The second may be regarded as an introduction to the more specialised branches of its subject. It will consist of three sections, dealing respectively with a brief description of the parts of organic and physical chemistry which relate to biological chemistry; the accumulation of energy by plants and the interconversion of carbohydrates, fats, and proteins; and the liberation of energy from the food substances.

Our Astronomical Column.

INTERESTING BINARY STARS.—Mr. J. S. Plaskett investigates, in vol. i., No. 2, of the Publications of the Dominion Astrophysics Observatory, Victoria, B.C., the orbit of the spectroscopic binary U Coronæ. Both spectra are visible, each being of type B3. The following are the elements of the two stars in terms of the sun, the brighter star being placed first:—Radii, 2·90, 4·74; masses, 4·27, 1·63; and densities, 0·175, 0·015. Taking the surface intensity of the bright star to be −2·7 magnitudes, as compared with the sun, of which the absolute magnitude is 4·86, the distance is deduced as 400 parsecs. It is, however, noted that the fainter star, though of the same spectral type, has only one-eighth of the surface brightness; this indicates that the correlation of surface brightness with type is less close than some physicists have assumed.

Two other eclipsing binaries of type B, μ^1 Scorpii and V Puppis, are discussed by Miss A. C. Maury in *Popular Astronomy* for January. The masses come out fairly large in these cases, $(m+m_1)\sin^3 i$ being 16·5 and 33 respectively. These would not be very different from the real masses, for, owing to the occurrence of partial eclipses, i cannot differ very much from 90°. μ^1 Scorpii is stated to be of the β Lyræ type, showing double eclipse and continual variation. Stellar tides are suggested in explanation of part of the change of light, and also of changes in the character of the spectrum.

A famous visual binary, 70 Ophiuchi, is discussed by F. Pavel, of Neubabelsberg, in *Ast. Nach.*, No. 5082. It is shown that the irregularities are explicable on the assumption that the principal star is describing the following small orbit owing to an unseen companion:—$T=1800{\cdot}0$, $a=0{\cdot}033''$, $e=0{\cdot}1$, $\lambda=150^\circ$, $i=0^\circ$, period $=6{\cdot}5$ y. The author then obtains for the orbit of the visual pair:—$T=1895{\cdot}965$, $a=4{\cdot}495''$, $e=0{\cdot}4988$, $\phi=29{\cdot}916^\circ$, $\omega=166{\cdot}648^\circ$, ☊ $=122{\cdot}184^\circ$, $i=58{\cdot}743^\circ$, period $=87{\cdot}710$ y. He obtains 0·36 for the ratio of masses, and 1·06 times the sun for the joint mass of the system on the assumption that the parallax is $0{\cdot}225''$.

THE GREEN RAY OR FLASH.—It has often been noticed when the sun is setting behind a well-defined horizon that the last appearance of the disc is a bright green flash. Various explanations have been put forward, some asserting that it was a case of complementary colour, due to fatigue of the retina. This was negatived by the flash being seen at sunrise. Another view was that the sea-water had something to do with it, but it was found that the effect could also be seen at a distant land horizon. There remained the explanation of atmospheric dispersion; but here again there were diversities of view, some holding that the normal colour dispersion would suffice, others invoking abnormal phenomena of the nature of the mirage.

L'Astronomie for December contains an interesting research by MM. A. Danjon and C. Rougier, of the Strasbourg Observatory. They installed a spectroscope on the roof of Strasbourg Cathedral, and were able to demonstrate that the phenomenon arises from normal dispersion. There is an image of the sun produced in light of each wave-length, and as the sun gets low these images are more and more widely separated. When the sun was a few degrees above the horizon the observers were able to obtain a spectrum showing red only when the slit was at the lower limb, and a spectrum with the red absent when it was at the upper limb. When the altitude is less the blue and violet are altogether absorbed, and the green image of the sun's upper limb is the last visible at sunset. Their horizon was formed by distant low hills, but they point out that a sea horizon may be better in that the presence of the bands of water-vapour helps to separate the red light from the green. The spectra obtained are reproduced in the article, and seem to settle the nature of the phenomenon beyond a doubt.